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4 PR 666-27512 (P.I.: Daniel E. Harris)

4.1 Interaction Between Cluster Gas and Radio Features of Cygnus A (P2098-5-89RI)

Although this was a ROSAT AO-1 project, the data were not delivered until Nov 1992. Preliminary evaluation of the image demonstrated: (a) the "6-month aspect offset syndrome" is present in the data, with an amplitude of approximately 15″; (b) there is discreet emission from the regions of the radio hot-spots; and (c) there appears to be a diminution of emission coincident with the radio lobes.

C. Carilli, CoI from NRAO visited the CfA for a week to work on data reduction (Feb, 93). We performed 3 operations to improve the spatial characteristics of the image. First we examined the PHA distribution of the main cluster gas, the features in the radio hotspot region, and the background. We found that if we cut channels 8–15, we would loose 3% of the source counts, but 21registration we performed two independent shifts. In the first, we used a smoothed version of each of the 29 obis to measure the peak of the main cluster emission, and then shifted each obi and coadded. In the second method, we divided the data into 5 time segments: 91apr, 91nov, 91dec, 92apr, and 92may. The position of a weak unresolved source 4′ off axis was then used to calculate the required shifts.

Analysis of the hotspot emission showed that the East spot is resolved with gross structure similar to the radio morphology. Counts were measured with "gun-sight" binning. Following conversion to flux with Obstime software, we used the observed radio spectrum to predict the synchrotron self Compton (SSC) contribution to the x-ray emission and found agreement with the measurements. We have been in contact with Biermann and Mannheim (Germany) to discuss the relevance of their model for emission from "proton induced cascades". This is a 'sister' process to the SSC emission. Perley, another Co-I from the NRAO visited for a week in April '93, and pursued Gould's and Marscher's published methods for dealing with SSC emission. Harris has obtained code which uses numerical methods for calculating SSC spectra, and this will be used to check our analytic estimates. We also estimated the parameters to explain the hotspot emission as an extension of the radio synchrotron spectrum or as thermal emission. Both of these possibilities appear unlikely.

Thermal emission from the bow shock has been evaluated, and we are also investigating explanations for the decrease in emission coincident with the inner parts of the radio lobes. Perley and Harris met with D. Clarke to discuss a collaboration on numerical simulations to model the jet evolution and lobe structure to see if we can reproduce some of the details of the interaction between the gas and radio features. We have performed a King model subtract, which emphasizes the effect of the "cavity" in the to gas, as well as accentuating the hot spot emission and the core source which is apparently unresolved and coincident with the optical galaxy.

5 PR 666-27514 (P.I.: Christine Jones-Forman)

5.1 Hot Gas and Dark Halos in Early-Type Galaxies (P2124-5-89RI)

A paper has been submitted to the Astrophysical Journal in which we report the results of our analysis of a deep 29 ksec ROSAT PSPC observation of the Fornax cluster which was centered on NGC1399. We use the observed x-ray surface brightness profile and gas temperature profile to determine the distribution of gravitating mass. The x-ray parameters required for measuring the gravitational mass can be traced to a distance of 18/arcmin from NGC1399, a distance of 126 kpc, assuming a distance modulus of 31.9 (equivalent to 24.0 Mpc; Ferguson 1989). We derive and discuss the radial distributions of the mass components of the system–the gas mass, the stellar mass in galaxies, and the dynamical mass. For the gaseous corona around NGC1399, we also measured the iron abundance to be approximately solar and constant with radius.

5.2 A Gravitational Lens in X-rays - 0957+461 (P2099-5-89RI)

The gravitational lens 0957+561 is comprised of a quasar at a redshift of 1.41 that is lensed by an intervening galaxy and surrounding cluster at a redshift of 0.36. A paper "ROSAT Images of the Gravitationally Lensed Quasar 0957+561" by Chartas, Falco, Forman, Jones, Schild and Shapiro was presented at the 31st Liege International Astrophysical Colloquium "Gravitational Lenses in the Universe" and will be submitted to the conference proceedings. From our analysis of the ROSAT observations, we find that the x-ray flux ratio of

7 PR 666-27229 (P.I.: Leon Golub)

7.1 Coronal Physics of the Lower Main Sequence: Relationships Among X-rays, Radio Emission and Magnetic Fields (P2106-5-89RI)

Ground-based magnetic field and Hα spectra of GL171.2a, EQ Vir and GL 182 were successfully obtained either simultaneous with, or at the same rotational phase as the ROSAT observations. All three sources showed strong X-ray emission, Hα emission, and magnetic flux, consistent with their short rotational periods (1.8, 3.9 and 1.9 days respectively). Together with AD Leo, these stars define the high flux end of the magnetic flux – X-ray flux relationship for stars with accurate, simultaneous measurements. We find magnetic can X-ray fluxes to be roughly linearly correlated. The results are being combined with similar data from later ROSAT programs for a paper on a correlations between magnetic and radiative fluxes in cool stars.

8 PR 666-27509 (P.I.: Jay Bookbinder)

8.1 X-ray Observations of the Eclipsing Millisecond Pulsar (P2108-5-89RI)

Using the HRI, we were successful in detecting the pulsar, and were able to place strong constraints on the x-ray emission from the nebula. Some marginal evidence for a variable x-ray flux is present in the data; followup observations will be requested.

The paper "X-rays from an Eclipsing Pulsar" (A.S. Fruchter, J.A. Bookbinder, M. Garcia, and C.D. Bailyn) has been published in the journal, Nature.

9 PR 666-27126 (P.I.: Frederick D. Seward)

9.1 Three Crab-Like SNR in the Large Magellanic Cloud (P2114-5-89RI)

One HRI observation was approved from this proposal. The exposure was made in July 1990. The purpose was to detect the outer shell of a SNR in the LMC. The observation is difficult because the remnant has an x-ray bright interior where an energetic 50 millisecond pulsar resides. The observation was success. The shell was observed and delineated. 23% of the x-rays originate in the shell. Measured properties of the shell ware used to derive the energy release of the supernova explosion. A paper describing these results has been written and submitted to the Astrophysical Journal.

10 PR 666-27508 (P.I.: Martin V. Zombeck)

10.1 X-ray Detection of A-Type Stars (P2116-5-89RI)

This grant, "X-ray Dection of A-Type Stars", led to the analysis of several ROSAT observations (four directly as a result of the observing time awarded for this grant, as well as several others of archival data and data awarded in connection with other grants). Our preliminary findings on A-type starts led to further study of B-type stars, which in turn led to the following publications, based in part on the work conducted under this grant:

1993 ROSAT detections of X-ray emission from young B-type stars (J.H.M.M. Schmitt, H. Zinnecker, R. Cruddace, and F.R. Harnden, Jr.). *Astrophysical Journal (Letters)*, volume 402, pages L13-L16.

1995 ROSAT observations of the Pleiades cluster I. X-Ray characteristics of a coeval stellar population (G. Micela, S. Sciortino, V. Kashyap, F.R. Harnden, Jr., and R. Rosner). *Astrophysical Journal*, accepted.

1994 *ROSAT* X-ray observations of late-type evolved stars: the relationship between coronal temperatures and luminosities (A. Maggio, S. Sciortino, and F.R. Harnden, Jr.). *Astrophysical Journal*, volume 432, pages 701-709.

1994 X-Ray Emission on Hybrid Stars: ROSAT Observations of α TrA and ι Aur (V. Kashyap, R. Rosner, F.R. Harnden, Jr., A. Maggio, G. Micela, and S. Sciortino). *Astrophysical Journal*, volume 431, pages 402-415.